* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

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CLAIMS

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(57) [Claim(s)]

[Claim 1] It has the sound-volume control circuit which controls the level of an input sound signal, and the voice amplifying circuit which amplifies the sound signal supplied from this sound-volume control circuit, and is supplied to a loudspeaker. While the above-mentioned voice amplifying circuit consists of amplifier and output resistance, preparing the outgoing end which takes out the sound signal supplied to the above-mentioned loudspeaker from the outgoing end of this output resistance and hanging feedback gain control on the above-mentioned amplifier from this outgoing end The current detector which detects the signal current which flows to the above-mentioned output resistance of the above-mentioned voice amplifying circuit, The loudspeaker actuation

circuit characterized by adding and constituting the current control means which controls the output current of the above-mentioned voice amplifying circuit when the above-mentioned sound-volume control circuit controls the level of the above-mentioned input sound signal according to the signal current detected by this current detector.

[Claim 2] The above-mentioned current detector is a loudspeaker actuation circuit according to claim 1 which consists of differential amplifier which detects the signal current which the potential difference between the ends of the above-mentioned output resistance is supplied, and flows to the above-mentioned output resistance.

[Claim 3] The above-mentioned current control means is the loudspeaker actuation circuit according to claim 1 constituted so that it might have further the peak hold circuit which carries out the predetermined time peak hold of the output of the above-mentioned current detector and the above-mentioned sound-volume control circuit might control the level of the above-mentioned input sound signal according to the output of this peak hold circuit. [Claim 4] The above-mentioned current control means detects the signal current which flows to the above-mentioned output resistance of the above-mentioned voice amplifying circuit. When this value of the detected signal current is compared with the value

equivalent to the allowance input current value of the above-mentioned loudspeaker and the value of the above-mentioned signal current exceeds the value equivalent to the above-mentioned allowance input current value The loudspeaker actuation circuit according to claim 1 to 3 constituted so that the output current of the above-mentioned voice amplifying circuit might be controlled, when the above-mentioned sound-volume control circuit reduced the level of the above-mentioned input sound signal according to the signal current by which detection was carried out [above-mentioned].

[Claim 5] While supplying the signal current by which detection was carried out [above-mentioned] to the above-mentioned sound-volume control circuit through a switch, the above-mentioned current control means Compare with the value equivalent to the allowance input current value of the above-mentioned loudspeaker the value of the signal current by which detection was carried out [above-mentioned] in a comparison circuit, and when the value with which the value of the above-mentioned signal current is equivalent to the above-mentioned allowance input current value with this comparison output is exceeded, the above-mentioned switch is carried out to ON. The loudspeaker actuation circuit according to claim 4 constituted so that the output current of the above-mentioned voice amplifying circuit might be controlled, when the

above-mentioned sound-volume control circuit reduced the level of the above-mentioned input sound signal according to the signal current by which detection was carried out [above-mentioned].

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the loudspeaker actuation circuit where the loudspeaker was protected good, when it is used by PA (public audio) system etc. and especially the output current becomes beyond the allowance input current value of a loudspeaker.

[0002]

[Description of the Prior Art] for example, in PA (public audio) system, in order to generate the amount of Oto, it was alike occasionally, it carried out, the output current of an amplifying circuit exceeded the allowance input current of a loudspeaker, and there was a possibility that accident, such as an open circuit by generation of heat of a voice coil, might occur. Then, in order to protect a

loudspeaker from such accident, the loudspeaker protection network which regulates the output current of an amplifying circuit below to allowance is examined.

[0003] That is, in drawing 5 , the sound signal supplied to the input terminal 71 is amplified with amplifier 72, and this amplified signal is supplied to a loudspeaker 75 through a resistor 73 and relay 74. Moreover, the electrical potential difference between the ends of a resistor 73 is supplied to an overcurrent sensing circuit 76, and the current which flows a resistor 73 with the drop electrical potential difference produced according to a current is detected. And the detecting signal from this overcurrent sensing circuit 76 is supplied to the control terminal of relay 74.

[0004] Therefore, in this circuit, while a loudspeaker 75 drives with the sound signal supplied to the input terminal 71, the electrical potential difference according to the signal current supplied among the ends of a resistor 73 at a loudspeaker 75 is generated. And the electrical potential difference between the ends of this resistor 73 is supplied to an overcurrent sensing circuit 76, the excessive current more than an allowance input current is detected, and when this detecting signal is obtained, supply of the excessive current more than the allowance input current from amplifier 72 to a loudspeaker 75 is intercepted by

turning off relay 74.

[0005] However, in this circuit, since the resistor 73 for excessive current detection is in the circuit of a loudspeaker 75, while the power impressed to a loudspeaker 75 decreases and effectiveness falls with the drop electrical potential difference of a resistor 73, there is also a possibility that distortion etc. may occur. Moreover, since the circuit of a loudspeaker 75 was cut by relay 74, there was also a possibility of the voice generated being intermittent, and sensing sense of incongruity in case it is listening.

[0006] On the other hand, the circuit as shown in JP,4-50913,U is proposed. That is, drawing 6 is drawing of the circuit proposed in this official report (drawing 1), and in this drawing 6 , it returns to the reversal input of an amplifier 82 through resistors 84 and 85 while the sound signal supplied to the input terminal 81 is supplied to the noninverting input of an amplifier 82 and the output signal of this amplifier 82 is supplied to the end of the voice coil of a loudspeaker 83.

[0007] Moreover, while the other end of the voice coil of a loudspeaker 83 is grounded through a resistor 86, this other end is supplied to the reversal input of amplifier 88 through a resistor 87. And it is grounded by the noninverting input of this amplifier 88, and the output of this amplifier 88 is supplied to the reversal input of amplifier 88 through a resistor 89. Furthermore, the output of this

amplifier 88 is supplied to the reversal input of amplifier 82 through resistors 90 and 91.

[0008] Therefore, in the circuit so far, in case positive feedback is hung on amplifier 82, especially a small loudspeaker is used, low-pass enhancement is achieved. However, in this circuit, when an excessive input is supplied, linearity gets worse by this positive feedback, and there is a fault of being easy to generate distortion. Then, in this circuit, as shown all over drawing, the feedback current-limiting circuit 92 is established in the output side of amplifier 82.

[0009] That is, in this feedback current-limiting circuit 92, the output signal of amplifier 82 is grounded through resistors 93 and 94, and this connection middle point is connected to the end of the parallel circuit of a capacitor 96 and a resistor 97 through diode 95. Furthermore the other end of this parallel circuit is grounded, and the end of this parallel circuit is connected to the base of a transistor 99 through a resistor 98. And the collector of this transistor 99 is connected at the connection middle point of resistors 90 and 91, and the emitter is made to be grounded.

[0010] If the output current of an amplifier 82 becomes excessive in this circuit by this, diode 95 will flow and the potential of the end of the parallel circuit of a capacitor 96 and a resistor 97 will rise. And if this potential becomes high,

between the collector of a transistor 99 and an emitter will flow, the positive feedback which leads resistors 90 and 91 is intercepted, and the output current of amplifier 82 is regulated.

[0011] However, in this circuit, although the output of amplifier 82 is detected, since the current itself which flows a loudspeaker 83 is not detected, the level detected by change of the impedance of a loudspeaker 83 will be changed, and fluctuation will be produced in the feedback current-limiting circuit 92 also in the output level which decreased and accomplished the amount of positive feedbacks of amplifier 82 with abbreviation regularity. In order to change the amount of feedback of amplifier 82 furthermore, there were troubles, like actuation of amplifier 82 also becomes instability.

[0012]

[Problem(s) to be Solved by the Invention] The trouble which is going to accomplish this application in view of such a point, and it is going to solve The power impressed to a loudspeaker with the drop electrical potential difference of a resistor with the conventional configuration since the resistor for excessive current detection is in the circuit of a loudspeaker decreases. Since effectiveness had not detected the current itself which there is a possibility that lowering, distortion, etc. may occur or flows a loudspeaker, there was [level

detected by change of the impedance of a loudspeaker] a trouble of producing fluctuation.

[0013]

[Means for Solving the Problem] The sound-volume control circuit 2 where the 1st means by this invention controls the level of an input sound signal, It has the voice amplifying circuit 3 which amplifies the sound signal supplied from this sound-volume control circuit, and is supplied to a loudspeaker. The above-mentioned voice amplifying circuit 3 consists of amplifier 31 and output resistance (resistors 36 and 37). While preparing the outgoing end which takes out the sound signal supplied to the above-mentioned loudspeaker from the outgoing end of this output resistance and hanging feedback gain control (resistor 38) on the above-mentioned amplifier from this outgoing end The current detector which detects the signal current which flows to the above-mentioned output resistance of the above-mentioned voice amplifying circuit (differential amplifying circuit 5), When the above-mentioned sound-volume control circuit controls the level of the above-mentioned input sound signal according to the signal current detected by this current detector, it is the loudspeaker actuation circuit characterized by adding and constituting the current control means which controls the output current of the above-mentioned

voice amplifying circuit.

[0014] The 2nd means by this invention is a loudspeaker actuation circuit 1st given in a means which consists of differential amplifier 5 which detects the signal current which the potential difference between the ends of the above-mentioned output resistance is supplied to the above-mentioned current detector, and flows to the above-mentioned output resistance. The 3rd means by this invention is the loudspeaker actuation circuit 1st given in a means constituted so that the above-mentioned current control means might be further equipped with the peak hold circuit 6 which carries out the predetermined time peak hold of the output of the above-mentioned current detector and the above-mentioned sound-volume control circuit might control the level of the above-mentioned input sound signal according to the output of this peak hold circuit. [0015] The 4th means by this invention the above-mentioned current control means The signal current which flows to the above-mentioned output resistance (resistors 36 and 37) of the above-mentioned voice amplifying circuit 3 is detected (differential amplifying circuit 5). When this value of the detected signal current is compared with the value (source 9 of reference voltage) equivalent to the allowance input current value of the above-mentioned loudspeaker (circuit 8) and the value of the above-mentioned signal current

exceeds the value equivalent to the above-mentioned allowance input current value When the above-mentioned sound-volume control circuit reduces the level of the above-mentioned input sound signal according to the signal current by which detection was carried out [above-mentioned], it is the loudspeaker actuation circuit 1-3rd given in a means constituted so that the output current of the above-mentioned voice amplifying circuit might be controlled.

[0016] While the 5th means by this invention supplies the signal current by which detection was carried out [above-mentioned] to the above-mentioned sound-volume control circuit 2 through a switch 7, the above-mentioned current control means The value of the signal current by which detection was carried out [above-mentioned] is compared with the value (source 9 of reference voltage) equivalent to the allowance input current value of the above-mentioned loudspeaker in a comparison circuit 8. When the value with which the value of the above-mentioned signal current is equivalent to the above-mentioned allowance input current value with this comparison output is exceeded, the above-mentioned switch is turned ON. When the above-mentioned sound-volume control circuit reduces the level of the above-mentioned input sound signal according to the signal current by which detection was carried out [above-mentioned], it is the loudspeaker actuation circuit 4th given in a means

constituted so that the output current of the above-mentioned voice amplifying circuit might be controlled.

[0017]

[Function] Since according to this the signal current which flows to the output resistance of the output stage within a feedback loop of a voice amplifying circuit is detected, the sound volume of a sound-volume control circuit is controlled by this detected signal current and it was made to set the output current constant While the output resistance of the output stage of a voice amplifying circuit does not decrease the power impressed to a loudspeaker An always good loudspeaker can be protected without the level detected by change of the impedance of a loudspeaker not producing fluctuation, and actuation becoming instability by change of the amount of feedback of amplifier.

[0018]

[Example] Drawing 1 is the block diagram showing the configuration of one example of the loudspeaker actuation circuit by this invention. In this drawing 1 , the sound signal supplied to the input terminal 1 is supplied to the voice amplifying circuit 3 through the sound-volume control circuit 2 which constitutes the loudspeaker actuation circuit 10 by this invention. The output signal of this voice amplifying circuit 3 is supplied to the end of the voice coil of a loudspeaker

4. The other end of the voice coil of this loudspeaker 4 is grounded.

[0019] Moreover, in this voice amplifying circuit 3, the output of the sound-volume control circuit 2 is connected to the noninverting input of an amplifier 31, and the output of this amplifier 31 is connected to the base of the transistors 34 and 35 of a complementary type through bias voltage 32 and 33, respectiveiy. The collector of these transistors 34 and 35 is connected to a power source and touch-down, respectively. And the emitter of these transistors 34 and 35 is mutually connected through resistors 36 and 37, and this connection middle point is connected to the end of the voice coil of a loudspeaker 4.

[0020] The connection middle point of the further above-mentioned resistors 36 and 37 is connected to the reversal input of amplifier 31 through resistors 38 and 39. While feedback is hung on this amplifier 31 by this, the signal from the sound-volume control circuit 2 is amplified and a loudspeaker 4 is supplied, the signal proportional to the outgoing end of amplifier 31 is taken out by considering transistors 34 and 35 as a push pull configuration at the connection middle point of resistors 36 and 37.

[0021] Then, while the potential of the ends (emitter of transistors 34 and 35) of these resistors 36 and 37 is supplied to the reversal input and noninverting input

of the differential amplifier 53 through the resistors 51 and 52 which constitute a differential amplifying circuit 5, respectively and the noninverting input of this differential amplifier 53 is grounded through a resistor 54, the output of the differential amplifier 53 returns to a reversal input through a resistor 55. The potential of the forward direction from the ends of resistors 36 and 37 and the potential of the negative direction are transformed into the potential based on touch-down by this.

[0022] Furthermore, the output of this differential amplifying circuit 5 is connected to the end of the parallel circuit of a capacitor 62 and a resistor 63 through the diode 61 which constitutes the peak hold circuit 6. The other end of this parallel circuit is grounded. The peak hold of the output signal from a differential amplifying circuit 5 is carried out by this, and the signal of this held peak value is supplied to the control terminal of the sound-volume control circuit 2 through a switch 7.

[0023] Moreover, the signal from the peak hold circuit 6 is supplied to one input of a comparison circuit 8, and the electrical potential difference which is further equivalent to the allowance input current value of the loudspeaker 4 from the source 9 of reference voltage is supplied to the input of another side of a comparison circuit 8. From this comparison circuit 8, when the signal from the

peak hold circuit 6 exceeds the electrical potential difference equivalent to the allowance input current value of a loudspeaker 4, an output is taken out by this, and ON control of the switch 7 is carried out with this output.

[0024] That is, in this circuit, the current which flows to the feedback resistor 38 of amplifier 31 can be disregarded compared with the current which flows to a loudspeaker 4. Therefore, it can be considered that the current which flows to a loudspeaker 4 is equal to the current passed by the output resistance machine 36 at the time of the forward voltage output of amplifier 31, and it is equal to the current passed by the output resistance machine 37 at the time of the negative voltage output of amplifier 31.

[0025] Moreover, the idling current passed through the output resistance machines 36 and 37 Since it is set to the level which can be disregarded compared with the current passed by the loudspeaker 4 on the level for which protection of a loudspeaker 4 is needed, the current which flows to a loudspeaker 4 also here It can be considered that it is equal to the current passed by the output resistance machine 36 at the time of the forward voltage output of amplifier 31, and equal to the current passed by the output resistance machine 37 at the time of the negative voltage output of amplifier 31.

[0026] Then, the electrical potential difference between the ends of the output

resistance machines 36 and 37 of amplifier 31 is transformed into the electrical potential difference of touch-down criteria in a differential amplifying circuit 5, fixed time amount electrical-potential-difference maintenance is performed in the peak hold circuit 6, and the sound-volume control circuit 2 is controlled by this electrical potential difference. When a current more excessive than the set point flows to a loudspeaker 4 by this, the electrical potential difference between the ends of the output resistance machines 36 and 37 of amplifier 31 becomes large, the electrical potential difference which appears in the peak hold circuit 6 also increases, the sound-volume control circuit 2 is controlled, signal level is reduced, and a loudspeaker 4 is protected.

[0027] In this way, according to above-mentioned equipment, the signal current which flows to the output resistance (resistors 36 and 37) of the output stage within a feedback loop of the voice amplifying circuit 3 is detected (differential amplifying circuit 5). Since the sound volume of the sound-volume control circuit 2 is controlled by this detected signal current and it was made to set the output current constant While the output resistance (resistors 36 and 37) of the output stage of the voice amplifying circuit 3 does not decrease the power impressed to a loudspeaker 4 The always good loudspeaker 4 can be protected without the level detected by change of the impedance of a loudspeaker 4 not producing

fluctuation, and actuation becoming instability by change of the amount of feedback of amplifier 31.

[0028] In addition, when the sound-volume control circuit 2 is controlled directly on the electrical potential difference which is an above-mentioned configuration, for example, appears in the peak hold circuit 6, in order to perform feedback control also in level without the need that control of the sound-volume control circuit 2 protects a loudspeaker 4, it will be in the condition that the amplitude modulation by the current which always flows to a loudspeaker 4 has started, and degradation of tone quality will arise.

[0029] So, the electrical potential difference which appears in the peak hold circuit 6 is compared with the electrical potential difference equivalent to the allowance input current value of the loudspeaker 4 from the source 9 of reference voltage in a comparison circuit 8, only when the electrical potential difference which appears in the peak hold circuit 6 is larger than the electrical potential difference equivalent to the allowance input current value of a loudspeaker 4, ON control of the switch 7 is carried out, and with the above-mentioned configuration, it is made to perform feedback control.

[0030] By this, when the electrical potential difference which appears in the peak hold circuit 6 is smaller than the electrical potential difference equivalent to the

allowance input current value of a loudspeaker 4, feedback control can be intercepted and degradation of the tone quality by amplitude modulation can be prevented. However, this invention excludes a switch 7, a comparison circuit 8, and source of reference voltage 9 grade, and even if it is always made to perform feedback control, it can operate.

[0031] Therefore, it sets in this circuit and is 1. Since there is no cutting in the circuit by relay as compared with the former, the sense of incongruity by intermittence of a sound does not arise.

2 Since the resistor for detection of an overcurrent is in a feedback loop as compared with the former, there is no reduction of the supply voltage to the loudspeaker 4 by the resistor for overcurrent detection.

3 In order not to change the amount of feedback of amplifier 31 as compared with the former, actuation of amplifier 31 is stable.

4 Since the current which flows to a loudspeaker 4 as compared with the former is detected, the relation of the output current fixed by sound-volume control with the level which starts feedback control is fixed.

[0032] In addition, in an above-mentioned circuit, the configuration of the voice amplifying circuit 3 may be used as BTL connection which prepared two equivalent amplifying circuits as shown in drawing 2 , supplied the signal

reversed through the inverter 30 to one side ([']] is attached and shown in a sign), and supplied both output to the ends of the voice coil of a loudspeaker 4. in this case, detection of the signal current -- either of two amplifying circuits -- a line -- **** -- it is good.

[0033] Moreover, in an above-mentioned circuit, the amplifier 31 of the voice amplifying circuit 3 can acquire the operation effectiveness that not only above-mentioned noninverting magnification but reversal magnification as shown in drawing 3 is the same.

[0034] In a further above-mentioned circuit, this invention can carry out not only the amplifying circuit that has the output stage of a push pull configuration but a configuration as shown in drawing 4 . That is, the output of an amplifier 31 is connected to the base of a transistor 34 in drawing 4 . While the collector of this transistor 34 is connected to a power source, the emitter of this transistor 34 is connected to the end of the voice coil of a loudspeaker 4 through the output resistance machine 36. Furthermore, it connects with the reversal input of amplifier 31 through the end resistors 38 and 39 of the voice coil of this loudspeaker 4. And the ends of the output resistance machine 36 are connected to the differential amplifier 53 through resistors 51 and 52, respectively.

[0035] While feedback is hung on amplifier 31 by this like an above-mentioned

circuit, the signal from the sound-volume control circuit 2 is amplified also in this circuit and a loudspeaker 4 is supplied, a signal completely equivalent to the outgoing end of amplifier 31 is taken out by the other end of a resistor 36. And by detecting the potential between the ends of this resistor 36, direct detection of the current passed by the loudspeaker 4 is carried out, and the good loudspeaker 4 can be protected using this detected value.

[0036]

[Effect of the Invention] Since according to this invention the signal current which flows to the output resistance of the output stage within a feedback loop of a voice amplifying circuit is detected, the sound volume of a sound-volume control circuit is controlled by this detected signal current and it was made to set the output current constant While the output resistance of the output stage of a voice amplifying circuit does not decrease the power impressed to a loudspeaker The always good loudspeaker could be protected without the level detected by change of the impedance of a loudspeaker having not produced fluctuation, and actuation becoming instability by change of the amount of feedback of amplifier.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram of an example of the loudspeaker actuation circuit by this invention.

[Drawing 2] It is the block diagram of other examples of the loudspeaker actuation circuit by this invention.

[Drawing 3] It is the block diagram of other examples of the loudspeaker actuation circuit by this invention.

[Drawing 4] It is the block diagram of other examples of the loudspeaker actuation circuit by this invention.

[Drawing 5] It is the block diagram of the conventional loudspeaker actuation circuit.

[Drawing 6] It is the block diagram of the conventional loudspeaker actuation circuit.

[Description of Notations]

10 Loudspeaker Actuation Circuit

1 Input Terminal

2 Sound-Volume Control Circuit

3 Voice Amplifying Circuit

4 Loudspeaker

31 Amplifier

32 33 Bias voltage

34 35 Transistor of a complementary type

36 37 Resistor

38 39 Resistor

5 Differential Amplifying Circuit

51 52 Resistor

53 Differential Amplifier

54 55 Resistor

6 Peak Hold Circuit

61 Diode

62 Capacitor

63 Resistor

7 Switch

8 Comparison Circuit

9 Source of Reference Voltage

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(54) DIGITAL POWER AMPLIFIER

(57)Abstract:

PROBLEM TO BE SOLVED: To decrease signal distortion components generated in the output signal of a digital power amplifier.

SOLUTION: By connecting load means 5, 6 and 7, among a PWM means 2 for converting a digital signal S6 to two one-side PWM signals S7 and S8, as relation of complement of '2', the output side of a first power switching means 3 for applying switching control by one of these one-side PWM signals and the output side of a second power switching means 4 for applying switching control by the other one-side PWM signal, the signal distortion component of a power signal outputted to this load means is decreased sufficiently.

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CLAIMS

[Claim(s)]

[Claim 1] An PWM means to be the digital power amplification which was made to carry out switching control of the power amplification stage, and to change an input signal into two single-sided PWM signals which have the relation of a two's complement, The 1st power-switching means by which switching control is carried out with one PWM signal of said two single-sided PWM signals, It has the 2nd power-switching means by which switching control is carried out with the PWM signal of another side of said two single-sided PWM signals. Between the output side of said 1st power-switching means, and the output side of said 2nd power-switching means Digital power amplification characterized by supplying an output signal to the connected load means.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the digital power amplification which applied when the switching control of the power amplification stage was made to be carried out, and consisted of suitable class D amplifiers.

[0002]

[Description of the Prior Art] The signal amplifier generally conventionally called a class D amplifier (class D amplification) is especially known as one gestalt of the signal amplifier of an audio frequency (audio frequency) band signal. As a typical example of this class D amplifier, as shown in drawing 2 A Pulse-Density-Modulation amplifier () [pulse width] Change of the signal level of the digital signal S1 of an audible frequency range inputted into the signal input edge 1 by modulation amplifier2 is changed into the PWM (pulse width modulation) signal S2 expressed with change of the pulse width direction. This signal S2 and this signal S2, and the wave-like PWM signal S3 which has a negative relation are generated by this Pulse-Density-Modulation amplifier 2.

[0003] And the drain side of this power-metal-oxide-semiconductor-field-effect-transistor component 4 that connected between the source of N channel power-metal-oxide-semiconductor-field-effect-transistor component 4 and the drains of N channel power-metal-oxide-semiconductor-field-effect-transistor

component 5, and was connected to the serial is connected to a power source Vcc. Ground the source side of this power-metal-oxide-semiconductor-field-effect-transistor component 5, and the power switching circuit section 3 is constituted. Supply and switch this PWM signal S2 to the gate of this power-metai-oxide-semiconductor-field-effect-transistor component 4, and this PWM signal S3 is supplied and switched to the gate of this power-metal-oxide-semiconductor-field-effect-transistor component 5. From this node between the source of the power-metal-oxide-semiconductor-field-effect-transistor component 4, and the drain of the power-metal-oxide-semiconductor-field-effect-transistor component 5 Power switching signal S4 of an PWM wave switched and generated according to change of the pulse width direction of this PWM signal S2 and the PWM signal S3 is outputted from the power switching circuit section 3.

[0004] And the audible frequency range analog power signal S5 corresponding to a digital signal S1 recovers this power switching signal S4 from this power switching signal S4 through the low-pass mold frequency filter section 6 which consisted of a choke coil 7 and a capacitor 8 further, this analog power signal S5 to which it restored is supplied to a loudspeaker 9, and this audible frequency

range analog power signal S5 is reproduced.

[0005] Moreover, there is a both-sides PWM modulated wave form shown in the single-sided PWM modulated wave form shown in drawing 2 B and drawing 2 C as a thing typical as this PWM modulated wave form of this power switching signal S4.

[0006] The wave which the wave shown in drawing 2 B by 1B expressed the single-sided PWM wave of PWM signal S4 when this digital power amplification is operated by the muting condition, and was shown by 2B The wave shown in 3B by showing the change of an one side PWM wave of PWM signal S4 when changing in the direction which the signal level of a digital signal S1 increases from 0 to a plus direction The change of an one side PWM wave of PWM signal S4 when changing in the direction in which the signal level of this signal S1 decreases in the minus direction from 0 is shown.

[0007] The wave which the wave shown in drawing 2 C by 1C expressed the both-sides PWM wave of PWM signal S4 when this digital power amplification is operated by the muting condition, and was shown by 2C The wave shown by 3C by showing the change of a both-sides PWM wave of PWM signal S4 when changing in the direction which the signal level of this signal S1 increases from 0 to a plus direction The change of a both-sides PWM wave of PWM signal S4

when changing in the direction in which the signal level of this signal S1 decreases in the minus direction from 0 is shown.

[0008] In addition, in drawing 2 B and 2C, arrow-head -> shows the direction of these change, Notation t shows each wave-like repeat period of PWM signal S4, and this repeat period t is always fixed [Notation].

[0009]

[Problem(s) to be Solved by the Invention] However, the wave of PWM signal S4 shown in this drawing 2 B In order to change asymmetrically with change of the signal level of a digital signal S1, that the time amount center-of-gravity location (wave center position of the section which has started) of the signal wave form of PWM signal S4 changes with change of such a signal wave form by the cause The technical problem that there were many distortion components contained in the audible frequency range analog power signal S5 recovered from power switching signal S4 of a low-pass mold frequency filter section 6 odor lever occurred.

[0010] Moreover, since the wave of PWM signal S4 shown in this drawing 2 C changes to both sides with change of the signal level of a digital signal S1, the problem from which the time amount center-of-gravity location of this signal wave form changes is solved. since [however,] the wave-like variability region

shown in drawing 2 C will become half as compared with it of drawing 2 B so that clearly if the wave shown in drawing 2 B is compared with the wave shown in drawing 2 C -- pulse width -- in resolution's becoming half, the technical problem that this distortion component could not be pressed down theoretically or thoroughly occurred.

[0011] Furthermore, when this PWM signal S4 is generated as a single-sided PWM wave shown in drawing 2 B, it is set again to each at the time of generating as a both-sides PWM wave shown in drawing 2 C. When the switching element of the power switching circuit section 3 is especially constituted from a power-metal-oxide-semiconductor-field-effect-transistor component, That a difference is in the build up time by the side of the positive edge of a switching waveform (rise time) and the fall time by the side of a negative edge (fall time) on the switching characteristic of this power-metal-oxide-semiconductor-field-effect-transistor component by the cause The technical problem that signal distortion was produced was in this audible frequency range analog power signal S5.

[0012] This invention is made in view of this conventional technical problem, and aims at solving the above-mentioned technical problem using two single-sided PWM signals which have the relation of a two's complement (2's complement) in

the digital signal of an audible frequency range at each other.

[0013]

[Means for Solving the Problem] In order to solve a technical problem which was mentioned above and to attain the above-mentioned object. The digital power amplification of this invention according to claim 1 An PWM means to be the digital power amplification which was made to carry out switching control of the power amplification stage, and to change an input signal into two single-sided PWM signals which have the relation of a two's complement, The 1st power-switching means by which switching control is carried out with one PWM signal of these two single-sided PWM signals, With the 2nd power-switching means by which switching control is carried out with the PWM signal of another side of these two single-sided PWM signals It is characterized by supplying an output signal to the load means connected between the output side of the power-switching means of these 1st, and the output side of said 2nd power-switching means.

[0014] By having constituted as mentioned above, the signal distortion component of the power signal of the audible frequency range outputted to this load means can fully be decreased with the digital power amplification of this invention according to claim 1.

[0015]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. Drawing 1 applies this invention to the class D amplifier in which an example of this invention operation is shown and one example of digital power amplification is shown.

[0016] First, an example of this D class power amplifier is explained. Drawing 1 is the block diagram having shown the important section of D class power amplifier, and this D class power amplifier 1 is constituted by the loudspeaker section 7 which are the Pulse-Density-Modulation amplifier (pulse width modulation amplifier) 2, the 1st power switching circuit section 3, the 2nd power switching circuit section 4, the 1st power LPF section 5, the 2nd power LPF section 6, and a sound reproduction means. Moreover, 1A is a signal input terminal.

[0017] The digital signal (digital audio signal) S6 of an audible frequency range inputted into signal input terminal 1A It is inputted into the Pulse-Density-Modulation amplifier 1. This Pulse-Density-Modulation amplifier 1 is minded. So that it may become the 1st PWM (pulse width modulation) signal S7 modulated according to the signal level of this digital signal S6, and the relation between this signal S7 and a two's complement (2's complement) The

2nd PWM signal S8 modulated according to the signal level of this digital signal S6 is generated, this 1st PWM signal S7 is inputted into the 1st power switching circuit section 3, and this 2nd PWM signal S8 is inputted into the 2nd power switching circuit section 4.

[0018] 1st PWM power signal S9 generated through this 1st power switching circuit section 3 where this 1st power switching circuit section 3 is switched according to the 1st PWM signal S7 It is inputted into the 1st power LPF section 5 which has the frequency characteristics which remove the carrier signal component of this 1st PWM power signal S9. The 2nd PWM power signal S10 generated through this 2nd power switching circuit section 4 where this 2nd power switching circuit section 4 is switched according to the 2nd PWM signal S8 It is inputted into the 2nd power LPF section 6 which has the frequency characteristics which remove the carrier signal component of this 2nd PWM power signal S10.

[0019] And separation generation of the power signal S11 of the 1st audible frequency range is carried out from 1st PWM power signal S9 through this 1st power LPF section 5, separation generation of the power signal S12 of the 2nd audible frequency range is carried out from the 2nd PWM power signal S10 through this 2nd power LPF section 6, the loudspeaker section 7 drives in

differential with these power signals S11 and S12, and sound is reproduced.

[0020] Next, between the 1st power switching circuit section 3 and the 2nd output of power switching circuit section 4 each which were shown in drawing 1 A In the BTL (balanced transformer less) connection circuit which the load which included the loudspeaker section 7 in the 1st power LPF section 5 and the 2nd power LPF section 6 iist which were connected to the serial was connected, and was constituted Each timing chart of 1st PWM power signal S9 given to this load and the 2nd PWM power signal S10 is shown and explained to drawing 1 B, and 1C and 1D. In addition, in drawing 1 B, and 1B and 1C, an arrow head shows the direction of change of each [these] signal wave form, Notation t shows each repeat period of each signal wave form, and this repeat period t is always fixed [Notation].

[0021] these signals S9 in case D class power amplifier 1 is in a muting (muting) condition when the zero state is maintained for the signal level of the digital signal S6 with which drawing 1 B was inputted into signal input terminal 1A namely, and S10 -- each signal wave form is shown, in this case, these signals S9 and the difference of S10 are always set to 0, and electrical-potential-difference S9-S10 given to this load turn into 0.

[0022] When drawing 1 C expresses the maximum amplitude level of this digital

signal S6 with **1, Since a timing chart in case the signal level of this digital signal S6 changes in the direction of +0.8 grade + as an example is shown, for example, single-sided PWM wave signal S9 expresses +0.8 and the single-sided PWM wave signal S10 expresses -0.8 The time amount width of face of the pulse signal of the difference of these one side PWM wave signal S9 in this case and the single-sided PWM wave signal S10 serves as a both-sides PWM modulated wave form of the direction of + where the pulse width of right-and-left both sides is symmetrical to the time amount core of this pulse signal so that clearly from drawing 1 C.

[0023] When drawing 1 D expresses the maximum amplitude level of this digital signal S6 with **1, Since a timing chart in case the signal level of this digital signal S6 changes in the direction of -0.6 grade - as an example is shown, for example, single-sided PWM wave signal S9 expresses -0.6 and the single-sided PWM wave signal S10 expresses +0.6 The time amount width of face of the pulse signal of the difference of these one side PWM wave signal S9 in this case and the single-sided PWM wave signal S10 serves as a both-sides PWM modulated wave form of the direction of - where the pulse width of right-and-left both sides is symmetrical to the time amount core of this pulse signal so that clearly from drawing 1 D.

[0024] That is, according to this example, even if the amplitude level of this digital signal S6 changes in which direction of the direction of +, or the direction of -, the wave of a signal (S9-S10) has the advantage that secondary distortion which is time-axis top bilateral symmetry, and originates in an PWM modulation since the direction of + and the direction of - make a wave symmetrical with the bottom of electrical-potential-difference shaft very best does not occur.

[0025] Moreover, in this example, the time amount width of face of the pulse signal of these signals S9 and the difference of S10 is determined only on the basis of each negative going edge of 1st PWM power signal S9. Therefore, when the switching element of the power switching circuit section 3 is especially constituted from a power-metal-oxide-semiconductor-field-effect-transistor component, there is an advantage to which that a difference is in the build up time by the side of the positive edge of a switching waveform (rise time) and the fall time by the side of a negative edge (fall time) can solve the technical problem that signal distortion is produced to this audible frequency range analog power signal S5 owing to on the switching characteristic of this power-metal-oxide-semiconductor-field-effect-transistor component. In addition, in this example, it explained as an example which applied this D class power amplifier 1 to the power amplifier of the signal of an audible frequency range.

However, this example can be applied to control of the power amplifier used for the various object, such as applying to the power amplifier for actuation control of a motor, without being limited to this.

[0026]

[Effect of the Invention] As explained above, according to the digital power amplification which was made to carry out switching control of the power amplification stage of this invention according to claim 1 An PWM means to change an input signal into two single-sided PWM signals which have the relation of a two's complement, The output side of the 1st power-switching means by which switching control is carried out with one PWM signal of these one side PWM signal, By having connected the load means between the output sides of the 2nd power-switching means by which switching control is carried out with the PWM signal of another side of these one side PWM signal, the signal distortion component of the power signal of the audible frequency range outputted to this load means can fully be decreased.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a diagram explaining actuation of the block diagram having shown an example of the class D amplifier in connection with the digital power amplification of this invention, and this class D amplifier.

[Drawing 2] It is a diagram explaining actuation of the block diagram having shown an exampie of the conventional class D amplifier, and this class D amplifier.

[Description of Notations]

2 [... The 1st power LPF section, 6 / ... The 2nd power LPF section, 7 / ... The loudspeaker section, S6 which are a sound reproduction means / ... A digital signal, S7 / ... The 1st PWM (pulsewidth modulation) signal, S8 / ... 2nd PWM signal] ..... Pulse-Density-Modulation amplifier (pulse width modulation amplifier), 3 ... The 1st power switching circuit section, 4 ... The 2nd power switching circuit section, 5

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最終頁に続く

(54)【発明の名称】　スピーカー駆動回路

1

(57)【特許請求の範囲】

【請求項１】　入力音声信号のレベルを制御する音量制御回路と、
この音量制御回路から供給される音声信号を増幅してスピーカーに供給する音声増幅回路とを有し、
上記音声増幅回路は増幅器と出力抵抗とからなり、この出力抵抗の出力端から上記スピーカーに供給する音声信号を取り出す出力端を設け、この出力端から上記増幅器に帰還利得制御を掛けると共に、
上記音声増幅回路の上記出力抵抗に流れる信号電流を検出する電流検出回路と、この電流検出回路により検出された信号電流に応じて上記音量制御回路が上記入力音声信号のレベルを制御することにより上記音声増幅回路の出力電流を制御する電流制御手段とを付加して構成したことを特徴とするスピーカー駆動回路。

2

【請求項２】　上記電流検出回路は、上記出力抵抗の両端間の電位差を供給され上記出力抵抗に流れる信号電流を検出する差動増幅器で構成される請求項１記載のスピーカー駆動回路。

【請求項３】　上記電流制御手段は、上記電流検出回路の出力を所定時間ピークホールドするピークホールド回路をさらに備え、
このピークホールド回路の出力に応じて上記音量制御回路が上記入力音声信号のレベルを制御するように構成された請求項１記載のスピーカー駆動回路。

【請求項４】　上記電流制御手段は、上記音声増幅回路の上記出力抵抗に流れる信号電流を検出し、この検出された信号電流の値と上記スピーカーの許容入力電流値に相当する値とを比較し、上記信号電流の値が上記許容入力電流値に相当する値を超えたときに、上記検出された

信号電流に応じて上記音量制御回路が上記入力音声信号のレベルを低下させることにより上記音声増幅回路の出力電流を制御するように構成された請求項１～３記載のスピーカー駆動回路。

【請求項５】　上記検出された信号電流をスイッチを介して上記音量制御回路に供給すると共に、

上記電流制御手段は、上記検出された信号電流の値と上記スピーカーの許容入力電流値に相当する値とを比較回路で比較し、この比較出力により上記信号電流の値が上記許容入力電流値に相当する値を超えたときに上記スイッチをオンにして、上記検出された信号電流に応じて上記音量制御回路が上記入力音声信号のレベルを低下させることにより上記音声増幅回路の出力電流を制御するように構成された請求項４記載のスピーカー駆動回路。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、ＰＡ（パブリックオーディオ）システム等で用いられ、特に出力電流がスピーカーの許容入力電流値以上となったときに、スピーカーが良好に保護されるようにしたスピーカー駆動回路に関するものである。

【０００２】

【従来の技術】例えばＰＡ（パブリックオーディオ）システムにおいては、大音量を発生させるために、往々にして増幅回路の出力電流がスピーカーの許容入力電流を超え、ボイスコイルの発熱による断線等の事故が発生する恐れがあった。そこでこのような事故からスピーカーを保護するために、増幅回路の出力電流を許容以下に規制するスピーカー保護回路が検討されている。

【０００３】すなわち図５においては、入力端子７１に供給された音声信号が増幅器７２で増幅され、この増幅された信号が抵抗器７３、リレー７４を通じてスピーカー７５に供給される。また抵抗器７３の両端間の電圧が過電流検出回路７６に供給され、電流に応じて生じる降下電圧によって抵抗器７３を流れる電流が検出される。そしてこの過電流検出回路７６からの検出信号がリレー７４の制御端子に供給される。

【０００４】従ってこの回路において、入力端子７１に供給された音声信号でスピーカー７５が駆動されると共に、抵抗器７３の両端間にスピーカー７５に供給される信号電流に応じた電圧が発生される。そしてこの抵抗器７３の両端間の電圧が過電流検出回路７６に供給されて許容入力電流以上の過大電流が検出され、この検出信号が得られたときにリレー７４がオフされることによって、増幅器７２からスピーカー７５への許容入力電流以上の過大電流の供給が遮断される。

【０００５】しかしながらこの回路においては、過大電流検出用の抵抗器７３がスピーカー７５の回線内にあるために、抵抗器７３の降下電圧によってスピーカー７５に印加される電力が減少され、効率が低下されると共に

歪み等が発生する恐れもある。また、リレー７４によってスピーカー７５の回線が切断されるために、発生される音声が断続し聴取の際に違和感を感じる恐れもあった。

【０００６】これに対して、実開平４－５０９１３号公報に示されるような回路が提案されている。すなわち図６は同公報で提案（第１図）されている回路の図であって、この図６においては、入力端子８１に供給された音声信号が増幅器８２の非反転入力に供給され、この増幅器８２の出力信号がスピーカー８３のボイスコイルの一端に供給されると共に、抵抗器８４、８５を通じて増幅器８２の反転入力に帰還される。

【０００７】また、スピーカー８３のボイスコイルの他端が抵抗器８６を通じて接地されると共に、この他端が抵抗器８７を通じて増幅器８８の反転入力に供給される。そしてこの増幅器８８の非反転入力に接地され、この増幅器８８の出力が抵抗器８９を通じて増幅器８８の反転入力に供給される。さらにこの増幅器８８の出力が抵抗器９０、９１を通じて増幅器８２の反転入力に供給される。

【０００８】従ってここまでの回路において、増幅器８２には正帰還が掛けられ、特に小型のスピーカーを使用する際に低域の増強が図られるものである。ところがこの回路において、過大な入力が供給されるとこの正帰還によってリニアリティが悪化し、歪みが発生しやすいという欠点がある。そこでこの回路においては、図中に示すように増幅器８２の出力側に帰還電流制限回路９２が設けられる。

【０００９】すなわちこの帰還電流制限回路９２において、増幅器８２の出力信号が抵抗器９３、９４を通じて接地され、この接続中点がダイオード９５を通じてコンデンサー９６及び抵抗器９７の並列回路の一端に接続される。さらにこの並列回路の他端が接地され、この並列回路の一端が抵抗器９８を通じてトランジスタ９９のベースに接続される。そしてこのトランジスタ９９のコレクタが抵抗器９０、９１の接続中点に接続され、エミッタが接地されるようにしている。

【００１０】これによってこの回路において、増幅器８２の出力電流が過大になるとダイオード９５が導通され、コンデンサー９６及び抵抗器９７の並列回路の一端の電位が上昇される。そしてこの電位が高くなるとトランジスタ９９のコレクタ、エミッタ間が導通され、抵抗器９０、９１を通じる正帰還が遮断されて増幅器８２の出力電流が規制される。

【００１１】ところがこの回路において、帰還電流制限回路９２では増幅器８２の出力を検出してはいるものの、スピーカー８３を流れる電流そのものを検出してはいないために、スピーカー８３のインピーダンスの変化によって検出されるレベルが変動され、また増幅器８２の正帰還量を減少して略一定と成した出力レベルにも変

動を生じてしまう。さらに増幅器８２の帰還量を変化させるために、増幅器８２の動作も不安定になるなどの問題点があった。

【００１２】

【発明が解決しようとする課題】この出願はこのような点に鑑みて成されたものであって、解決しようとする問題点は、従来の構成では、過大電流検出用の抵抗器がスピーカーの回線内にあるために抵抗器の降下電圧によってスピーカーに印加される電力が減少され、効率が低下や歪み等が発生する恐れがあるか、または、スピーカーを流れる電流そのものを検出してはいないためにスピーカーのインピーダンスの変化によって検出されるレベルが変動を生じてしまうなどの問題点があったというものである。

【００１３】

【課題を解決するための手段】本発明による第１の手段は、入力音声信号のレベルを制御する音量制御回路２と、この音量制御回路から供給される音声信号を増幅してスピーカーに供給する音声増幅回路３とを有し、上記音声増幅回路３は増幅器３１と出力抵抗（抵抗器３６、３７）とからなり、この出力抵抗の出力端から上記スピーカーに供給する音声信号を取り出す出力端を設け、この出力端から上記増幅器に帰還利得制御（抵抗器３８）を掛けると共に、上記音声増幅回路の上記出力抵抗に流れる信号電流を検出する電流検出回路（差動増幅回路５）と、この電流検出回路により検出された信号電流に応じて上記音量制御回路が上記入力音声信号のレベルを制御することにより上記音声増幅回路の出力電流を制御する電流制御手段とを付加して構成したことを特徴とするスピーカー駆動回路である。

【００１４】本発明による第２の手段は、上記電流検出回路は、上記出力抵抗の両端間の電位差を供給され上記出力抵抗に流れる信号電流を検出する差動増幅器５で構成される第１の手段記載のスピーカー駆動回路である。本発明による第３の手段は、上記電流制御手段は、上記電流検出回路の出力を所定時間ピークホールドするピークホールド回路６をさらに備え、このピークホールド回路の出力に応じて上記音量制御回路が上記入力音声信号のレベルを制御するように構成された第１の手段記載のスピーカー駆動回路である。

【００１５】本発明による第４の手段は、上記電流制御手段は、上記音声増幅回路３の上記出力抵抗（抵抗器３６、３７）に流れる信号電流を検出（差動増幅回路５）し、この検出された信号電流の値と上記スピーカーの許容入力電流値に相当する値（基準電圧源９）とを比較（回路８）し、上記信号電流の値が上記許容入力電流値に相当する値を超えたときに、上記検出された信号電流に応じて上記音量制御回路が上記入力音声信号のレベルを低下させることにより上記音声増幅回路の出力電流を制御するように構成された第１～３の手段記載のスピーカー駆動回路である。

【００１６】本発明による第５の手段は、上記検出された信号電流をスイッチ７を介して上記音量制御回路２に供給すると共に、上記電流制御手段は、上記検出された信号電流の値と上記スピーカーの許容入力電流値に相当する値（基準電圧源９）とを比較回路８で比較し、この比較出力により上記信号電流の値が上記許容入力電流値に相当する値を超えたときに上記スイッチをオンにして、上記検出された信号電流に応じて上記音量制御回路が上記入力音声信号のレベルを低下させることにより上記音声増幅回路の出力電流を制御するように構成された第４の手段記載のスピーカー駆動回路である。

【００１７】

【作用】これによれば、音声増幅回路の帰還ループ内出力段の出力抵抗に流れる信号電流を検出し、この検出された信号電流によって音量制御回路の音量を制御して出力電流を一定とするようにしたので、音声増幅回路の出力段の出力抵抗はスピーカーに印加される電力を減少させることが無いと共に、スピーカーのインピーダンスの変化によって検出されるレベルが変動を生じてしまうことがなく、また増幅器の帰還量の変化によって動作が不安定になることもなく、常に良好なスピーカーの保護を行うことができる。

【００１８】

【実施例】図１は本発明によるスピーカー駆動回路の一実施例の構成を示すブロック図である。この図１において、入力端子１に供給された音声信号が、本発明によるスピーカー駆動回路１０を構成する音量制御回路２を通じて音声増幅回路３に供給される。この音声増幅回路３の出力信号がスピーカー４のボイスコイルの一端に供給される。このスピーカー４のボイスコイルの他端は接地される。

【００１９】またこの音声増幅回路３においては、音量制御回路２の出力が増幅器３１の非反転入力に接続され、この増幅器３１の出力がバイアス電圧３２、３３を通じてそれぞれ相補型のトランジスタ３４、３５のベースに接続される。これらのトランジスタ３４、３５のコレクタがそれぞれ電源及び接地に接続される。そしてこれらのトランジスタ３４、３５のエミッタが抵抗器３６、３７を通じて互いに接続され、この接続中点がスピーカー４のボイスコイルの一端に接続される。

【００２０】さらに上述の抵抗器３６、３７の接続中点が抵抗器３８、３９を通じて増幅器３１の反転入力に接続される。これによって、この増幅器３１には帰還が掛けられ、音量制御回路２からの信号が増幅されてスピーカー４に供給されると共に、抵抗器３６、３７の接続中点には、トランジスタ３４、３５がプッシュプル構成とされることによって、増幅器３１の出力端に比例した信号が取り出されている。

【００２１】そこでこの抵抗器３６、３７の両端（トラ

ンジスタ３４、３５のエミッタ）の電位が、それぞれ差動増幅回路５を構成する抵抗器５１、５２を通じて差動増幅器５３の反転入力及び非反転入力に供給され、この差動増幅器５３の非反転入力が抵抗器５４を通じて接地されると共に、差動増幅器５３の出力が抵抗器５５を通じて反転入力に帰還される。これによって抵抗器３６、３７の両端からの正方向の電位及び負方向の電位が接地中心の電位に変換される。

【００２２】さらにこの差動増幅回路５の出力がピークホールド回路６を構成するダイオード６１を通じてコンデンサ６２及び抵抗器６３の並列回路の一端に接続される。この並列回路の他端が接地される。これによって差動増幅回路５からの出力信号がピークホールドされ、このホールドされたピーク値の信号がスイッチ７を通じて音量制御回路２の制御端子に供給される。

【００２３】またピークホールド回路６からの信号が比較回路８の一方の入力に供給され、さらに基準電圧源９からのスピーカー４の許容入力電流値に相当する電圧が比較回路８の他方の入力に供給される。これによってこの比較回路８からは、ピークホールド回路６からの信号がスピーカー４の許容入力電流値に相当する電圧を超えたときに出力が取り出され、この出力にてスイッチ７がオン制御される。

【００２４】すなわちこの回路において、増幅器３１の帰還抵抗器３８に流れる電流はスピーカー４に流れる電流に比べて無視できるものである。従ってスピーカー４に流れる電流は、増幅器３１の正電圧出力時は出力抵抗器３６に流される電流に等しく、また増幅器３１の負電圧出力時は出力抵抗器３７に流される電流に等しいとみなすことができる。

【００２５】また、出力抵抗器３６、３７を通じて流されるアイドリング電流は、スピーカー４の保護が必要とされるレベルではスピーカー４に流される電流に比べて無視できるレベルとなるため、ここでもスピーカー４に流れる電流は、増幅器３１の正電圧出力時は出力抵抗器３６に流される電流に等しく、また増幅器３１の負電圧出力時は出力抵抗器３７に流される電流に等しいとみなすことができる。

【００２６】そこで増幅器３１の出力抵抗器３６、３７の両端間の電圧を差動増幅回路５で接地基準の電圧に変換し、ピークホールド回路６で一定時間電圧保持を行い、この電圧で音量制御回路２を制御する。これにより、例えばスピーカー４に設定値より過大な電流が流れた場合には、増幅器３１の出力抵抗器３６、３７の両端間の電圧が大きくなり、ピークホールド回路６に現れる電圧も増大し、音量制御回路２を制御し、信号レベルを低下させてスピーカー４を保護する。

【００２７】こうして上述の装置によれば、音声増幅回路３の帰還ループ内出力段の出力抵抗（抵抗器３６、３７）に流れる信号電流を検出（差動増幅回路５）し、この検出された信号電流によって音量制御回路２の音量を制御して出力電流を一定とするようにしたので、音声増幅回路３の出力段の出力抵抗（抵抗器３６、３７）はスピーカー４に印加される電力を減少させることが無いと共に、スピーカー４のインピーダンスの変化によって検出されるレベルが変動を生じてしまうことがなく、また増幅器３１の帰還量の変化によって動作が不安定になることもなく、常に良好なスピーカー４の保護を行うことができるものである。

【００２８】なお上述の構成で、例えばピークホールド回路６に現れる電圧で音量制御回路２を直接制御した場合には、音量制御回路２の制御がスピーカー４を保護する必要のないレベルにおいてもフィードバック制御を行うために、常にスピーカー４に流れる電流による振幅変調が掛かっている状態となり、音質の劣化が生じる。

【００２９】そこで上述の構成では、ピークホールド回路６に現れる電圧と基準電圧源９からのスピーカー４の許容入力電流値に相当する電圧を比較回路８で比較し、ピークホールド回路６に現れる電圧がスピーカー４の許容入力電流値に相当する電圧より大きい場合のみスイッチ７をオン制御して、フィードバック制御を行うようにしている。

【００３０】これによって、ピークホールド回路６に現れる電圧がスピーカー４の許容入力電流値に相当する電圧より小さい場合には、フィードバック制御を遮断して振幅変調による音質の劣化を防ぐことができる。ただし、本願の発明は、スイッチ７、比較回路８、基準電圧源９等を省いて、常にフィードバック制御を行うようにしても動作することができる。

【００３１】従ってこの回路において、

１　従来と比較してリレーによる回路に切断がないため、音の断続による違和感が生じることがない。

２　従来と比較してフィードバックループ内に過電流の検出用抵抗器があるため、過電流検出用抵抗器によるスピーカー４への供給電力の減少がない。

３　従来と比較して増幅器３１の帰還量を変化させないため、増幅器３１の動作が安定である。

４　従来と比較してスピーカー４に流れる電流を検出しているため、フィードバック制御を開始するレベルと音量制御により一定にした出力電流の関係が一定である。

【００３２】なお上述の回路において、音声増幅回路３の構成は、例えば図２に示すように同等の増幅回路を２系統設け、一方（符号に〔′〕を付して示す）にはインバーター３０を通じて反転した信号を供給し、両者の出力をスピーカー４のボイスコイルの両端に供給したＢＴＬ接続として用いてもよい。この場合に、信号電流の検出は、２系統の増幅回路のいずれから行ってもよい。

【００３３】また上述の回路において、音声増幅回路３の増幅器３１は、上述の非反転増幅に限らず、例えば図３に示すような反転増幅でも同様の作用効果を得ること

ができるものである。

【００３４】さらに上述の回路において、本発明はプッシュプル構成の出力段を有する増幅回路に限らず、例えば図４に示すような構成でも実施することができる。すなわち図４において、増幅器３１の出力がトランジスタ３４のベースに接続される。このトランジスタ３４のコレクタが電源に接続されると共に、このトランジスタ３４のエミッタが出力抵抗器３６を通じてスピーカー４のボイスコイルの一端に接続される。さらにこのスピーカー４のボイスコイルの一端抵抗器３８、３９を通じて増幅器３１の反転入力に接続される。そして出力抵抗器３６の両端がそれぞれ抵抗器５１、５２を通じて差動増幅器５３に接続される。

【００３５】これによってこの回路においても、上述の回路と同様に増幅器３１には帰還が掛けられ、音量制御回路２からの信号が増幅されてスピーカー４に供給されると共に、抵抗器３６の他端には増幅器３１の出力端と全く同等の信号が取り出される。そしてこの抵抗器３６の両端間の電位を検出することによって、スピーカー４に流される電流が直接検出され、この検出された値を用いて良好なスピーカー４の保護を行うことができる。

【００３６】

【発明の効果】この発明によれば、音声増幅回路の帰還ループ内出力段の出力抵抗に流れる信号電流を検出し、この検出された信号電流によって音量制御回路の音量を制御して出力電流を一定とするようにしたので、音声増幅回路の出力段の出力抵抗はスピーカーに印加される電力を減少させることが無いと共に、スピーカーのインピーダンスの変化によって検出されるレベルが変動を生じてしまうことがなく、また増幅器の帰還量の変化によって動作が不安定になることもなく、常に良好なスピーカーの保護を行うことができるようになった。

【図面の簡単な説明】

＊【図１】本発明によるスピーカー駆動回路の一例の構成図である。

【図２】本発明によるスピーカー駆動回路の他の例の構成図である。

【図３】本発明によるスピーカー駆動回路の他の例の構成図である。

【図４】本発明によるスピーカー駆動回路の他の例の構成図である。

【図５】従来のスピーカー駆動回路の構成図である。

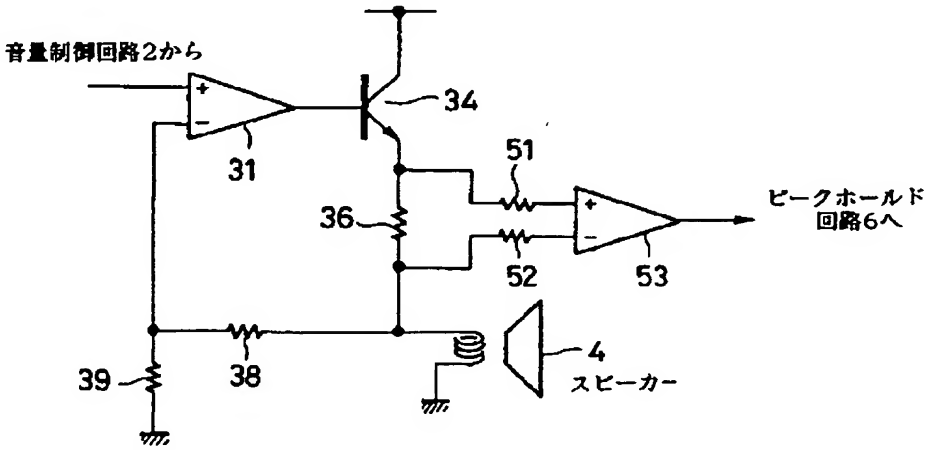
【図６】従来のスピーカー駆動回路の構成図である。

【符号の説明】

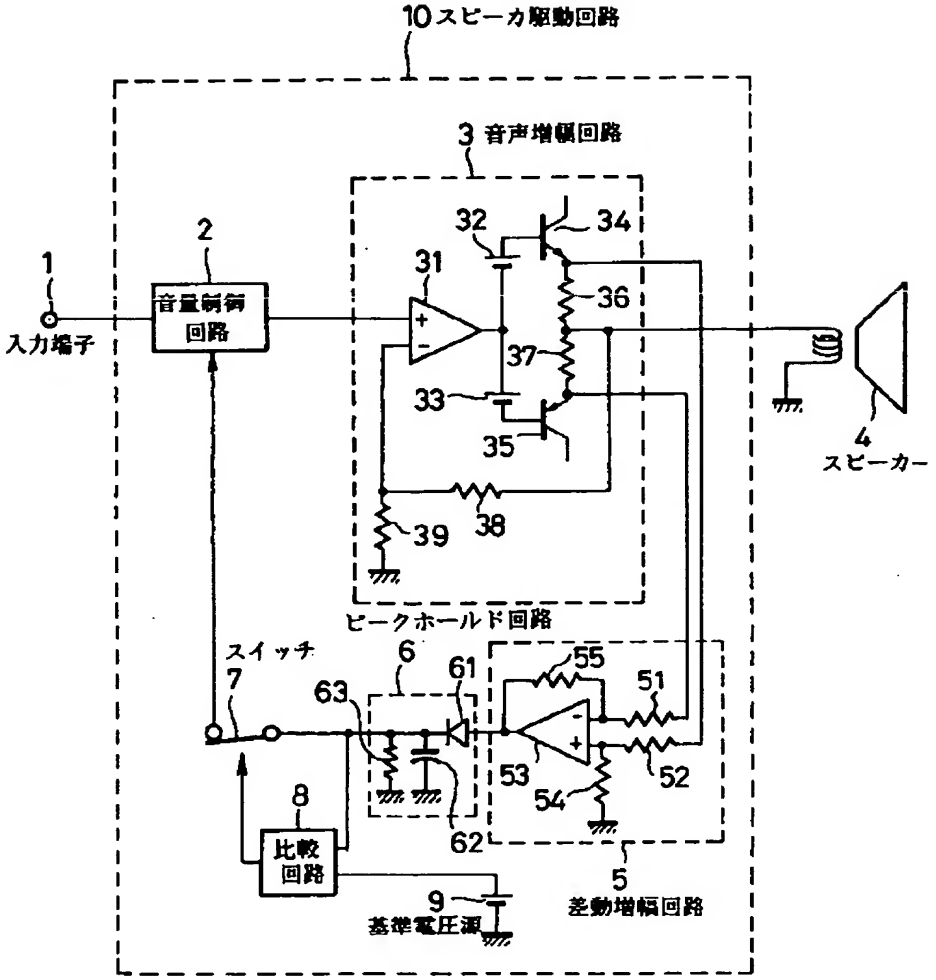
１０　スピーカー駆動回路
１　入力端子
２　音量制御回路
３　音声増幅回路
４　スピーカー
３１　増幅器
３２、３３　バイアス電圧
３４、３５　相補型のトランジスタ
３６、３７　抵抗器
３８、３９　抵抗器
５　差動増幅回路
５１、５２　抵抗器
５３　差動増幅器
５４、５５　抵抗器
６　ピークホールド回路
６１　ダイオード
６２　コンデンサ
６３　抵抗器
７　スイッチ
８　比較回路
９　基準電圧源

＊

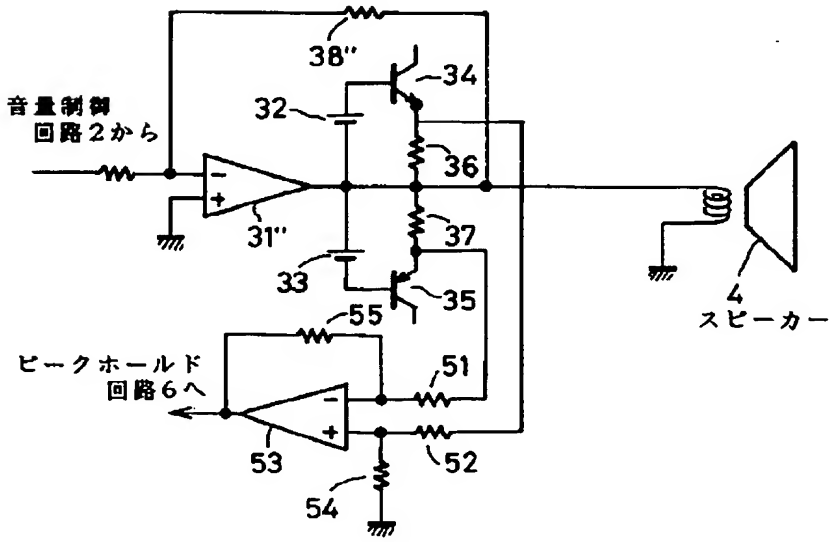
【図４】



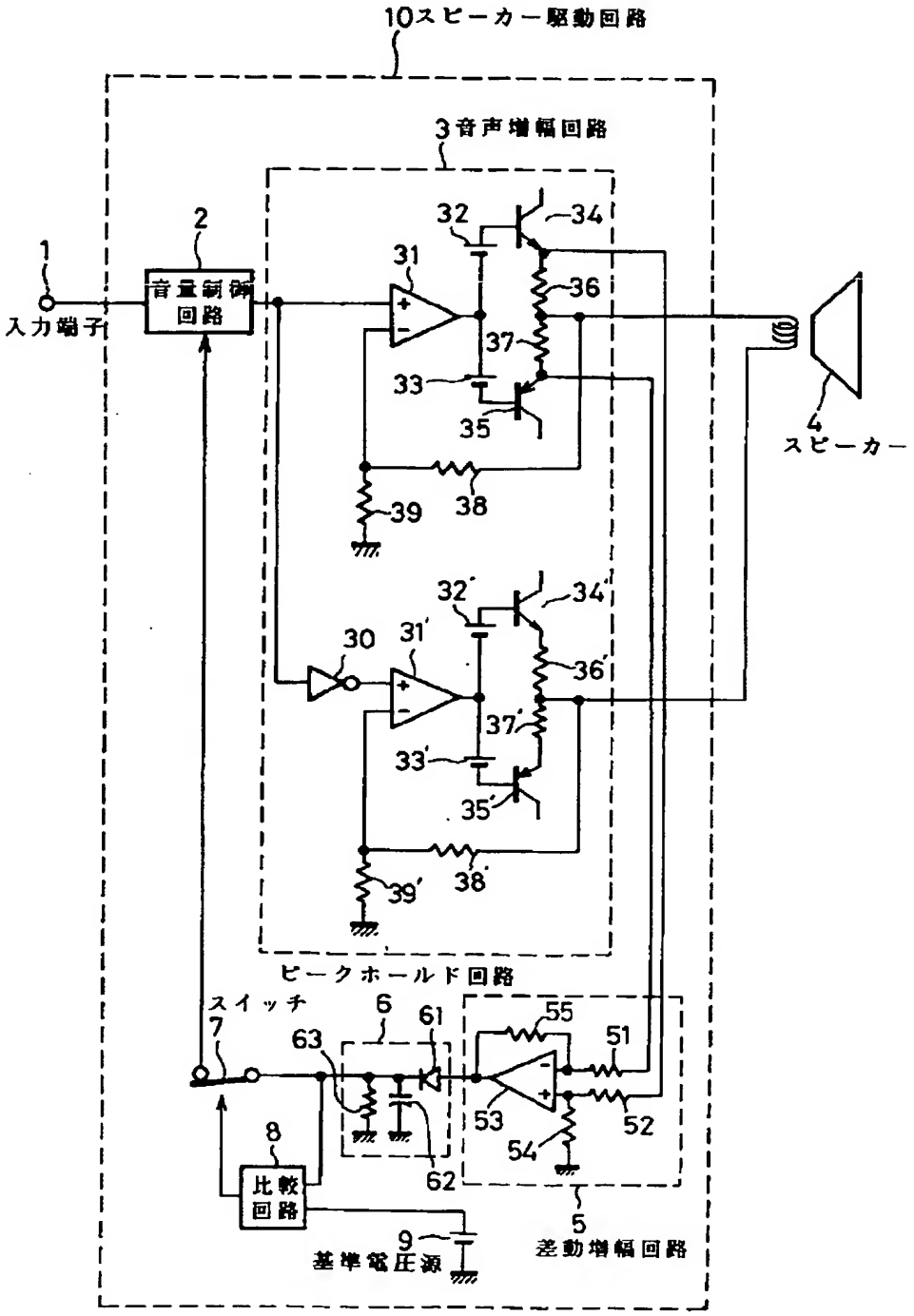
【図１】


10スピーカ駆動回路
3 音声増幅回路
2
1
入力端子
音量制御回路
32
34
31
36
37
33
35
4
スピーカー
39
38
ピークホールド回路
スイッチ
6
7
63
61
55
51
53
54
52
8
比較回路
62
5
差動増幅回路
9
基準電圧源

【図３】


38''
34
音量制御回路２から
32
36
31''
37
33
35
4
スピーカー
55
ピークホールド回路６へ
51
53
52
54

【図２】


10スピーカー駆動回路
3音声増幅回路
2
1
入力端子
音量制御回路
32
34
31
36
37
33
35
4
スピーカー
39
38
32'
34'
30
31'
36'
37'
33'
35'
39'
38'
ピークホールド回路
スイッチ
7
6
61
63
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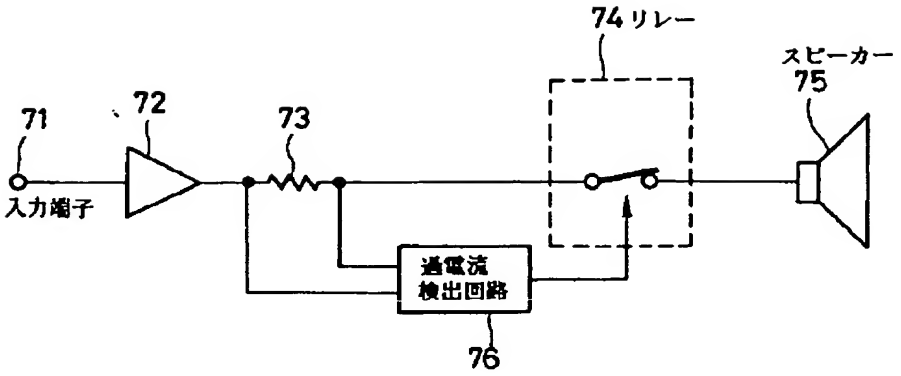
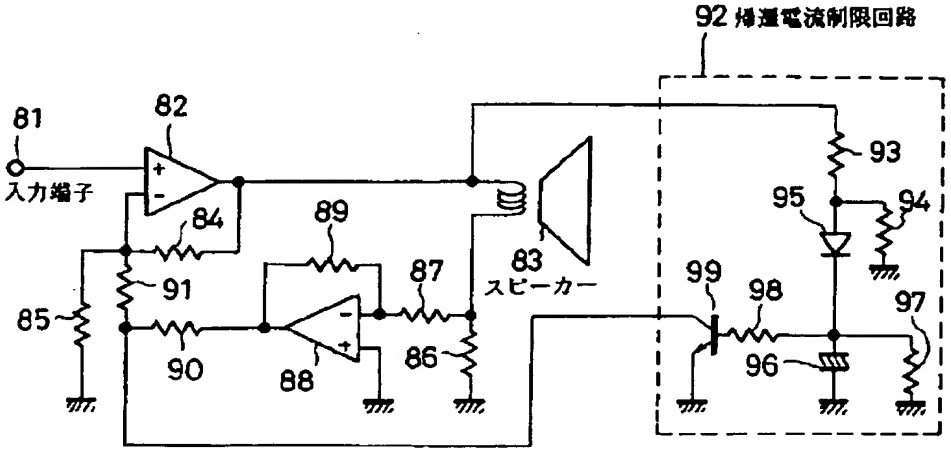
51
53
52
54
62
8
比較回路
9
基準電圧源
5
差動増幅回路

【図５】



【図６】



フロントページの続き

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